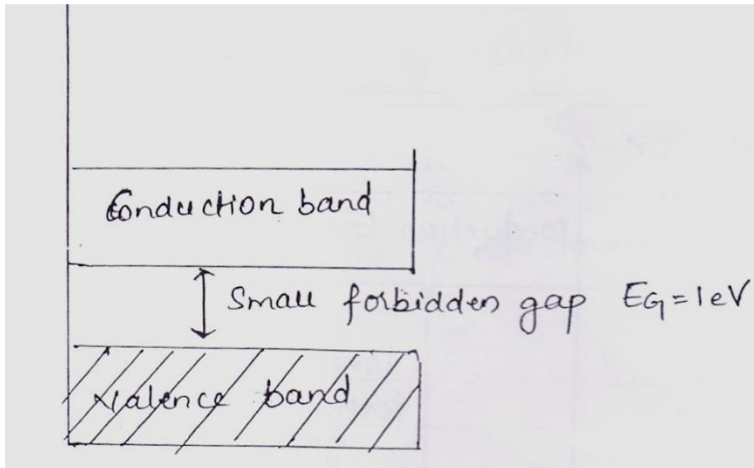
MODEL ANSWER
SUMMER– 18 EXAMINATION

Subject Title:- Electronic Engineering Materials **Subject Code:- 22217**

Important Instructions to examiners:

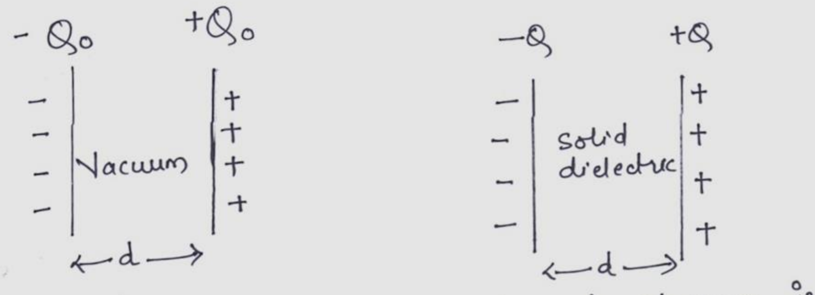
1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills.
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

Q. No.	Sub Q.N.	Answer	Marking Scheme
Q.1		**Attempt any FIVE of the following :**	**10 Marks**
	a)	**Define the term 'Photoelectric emission.**	**2 Marks**
	Ans:	Photoelectric emission is defined as "emission of electron from the metal surface, when illuminated by light"	**2 Marks**
	b)	**List dielectric materials (any four).**	**2 Marks**
	Ans:	i)Mica ii) Porcelain iii)polythene iv)Bakelite v)polyvinyl chloride vi)rubber vii)cotton viii)silk ix)glass x)paper &boards xi)wood xii) enamel covering xiii)transformer oil xiv)polymers.	**Any four 1/2 Marks each**
	c)	**Define the term 'Permeability'. State its unit.**	**2 Marks**
	Ans:	The capability of the magnetic material to conduct the magnetic flux is known as permeability. Unit :H/m or H m-1 (henries per meter),or N.A-2 (Newton per Ampere square)	**1 Marks** **1 Marks**
	d)	**Sketch energy band diagram of intrinsic semiconductor.**	**2 Marks**
	Ans:		**2 Marks**



	e)	**List electrical conducting material (any four).**	**2 Marks**
	Ans:	Copper, gold ,silver ,aluminum , mercury ,steel, iron, sea water	**1/2 marks each**
	f)	**'Pentavalent impurity materials are called as Donor impurity.' Justify your answer.**	**2 Marks**
	Ans:	Pentavalent impurity materials like Arsenic ,phosphorus and Antimony has 5 valence electron ,out of which four are utilized in bonding with intrinsic semiconductor like silicon or germanium and the one electron left is donated to act as charge carrier hence, Pentavalent impurity materials are called as Donor impurity.'	**2 Marks**
	g)	**State working principle of LED.**	**2 Marks**
	Ans:	LED works on the principle of "electroluminescence" In electroluminescent materials, which are semiconductors the energy of an electric filed produces a localized high free charge carrier density and light is emitted when the free charge carrier combine.	**1 Marks** **1 Marks**
Q 2		**Attempt any THREE :**	**12 Marks**
	a)	**State the effect of following factors on resistivity of electrical conducting material :(i) Temperature** **(ii) Alloying** **(iii) Cold work** **(iv) Age Hardening**	**4 Marks**
	Ans:	**(i)Temperature:** As the temperature increases the resistivity of material increases, hence conductivity decreases. **(ii) Alloying:** Addition of another metal to a pure metal will increase the resistivity considerably hence conductivity decreases. **(iii) Cold work:** Mechanical distortion taking place in metal increases resistivity of a metal thereby decreasing the conductivity.	**1 Marks** **1 Marks** **1 Marks** **1 Marks**

		(iv) Age Hardening: The age hardness of conducting material increases the resistivity which decreases the conductivity.	
	b)	**State four selection factors for selecting an insulating material.**	**4 Marks**
	Ans:	**Four selection factors for selecting an insulating material are** i)Electrical ii)Mechanical iii)Thermal iv)Chemical **i)** **Electrical factor:** A good insulating material should have high resistivity and low leakage current. It should have high dielectric strength and small dielectric loss. **ii)** **Mechanical factor:** A good insulating material should have sufficient mechanical strength to withstand vibrations. **iii)** **Thermal factor:** A good insulating material should have small thermal expansion to avoid damages, It should be non ignitable and self extinguishable. **iv)** **Chemical factor:** A good insulating material should be resistant to oils, gas, fumes acids and alkalies. It should not absorb water as water reduces insulation resistance and dielectric strength.	**1 Marks** **1 Marks** **1 Marks** **1 Marks**
	c)	**Describe the etfect on the capacitance of the dielectric material on the basis of factors polarizability and permittivity.**	**4 Marks**
	Ans:	The function of a capacitor is to store charge. its capacity to store charge is measured in terms of capacitance (C) The presence of dielectric material between the two conducting material in capacitor helps the capacitor to store charge or else the circuit gets completed and current starts flowing. When electric field is applied across the dielectric material ,the electrons of atoms are acted upon by the electric field and are displaced in a direction opposite to that of electric field this results in seperation of positive and negative charges hence dipoles are created in the dielectric material and said to be polarized	**2 Marks**



The capacitance of a capacitor in Vacuum is given as

$$C_0 = \frac{Q_0}{V}$$

The capacitance of a capacitor in solid dielectric is given as

$$C = \frac{Q}{V}$$

But $C \propto \frac{A}{d}$

where, A = Area of cross section of metal plates
d = distance between metal plates.

$\therefore$ for solid dielectric $C = \epsilon \frac{A}{d}$

for Vacum dielectic $C_0 = \epsilon_0 \frac{A}{d}$

where ϵ = Absolute permittivity of solid dielectric
ϵ_0 = Absolute permittivity of Vacum dielectic

$$\therefore \frac{C}{C_0} = \frac{\epsilon}{\epsilon_0}$$

$$\frac{C}{C_0} = \epsilon_r$$ (Relative permittivity or dielectric constant)

2 Marks

d)	**Describe Peltier thermoelectric effect. State its application.**	**4 Marks**
Ans:	1. Thermoelectric effect deals with relation between heat and electrical energy. The motion of electron gets altered by the flow of current or temperature gradient. This is the basis of thermoelectric effect.	**3 Marks**

2. When a current is passed through the junction of two different metals then heat is absorbed or liberated depending on the direction of current this effect is called as Peltier effect.

3. The heat is called as Peltier heat. Peltier heat is reversible which means that the absorption can be changed to liberation by reversing the direction of current.

Application: This effect is used in Refrigeration — **1 Marks**

Q. 3 — Attempt any THREE : — 12 Marks

a) Compare P-type semiconductor with N-type semiconductor on the basis of
(i) Majority charge carrier
(ii) Minority charge carrier
(iii) Impurity material
(iv) Fermi-level position in energy band diagram. — **4 Marks**

Ans: (**1 marks for each point**)

	P-type semiconductor	**N-type semiconductor**
(i) Majority charge carrier	Holes	Electron
(ii) Minority charge carrier	Electron	Holes
(iii) Impurity material	Trivalent such as Boron, calcium Indium etc	Pentavalent such as Phosphorous antimony arsenic
(iv) Fermi-level position in energy band diagram.	Fermi level lies towards valance band	Fermi levels lies towards conduction band

b) List specifications of micro relay. (any four) — **4 Marks**

Ans: **specifications of micro relay are :** (**1 marks for each point**)

1) Contact arrangement

2) Limiting making current

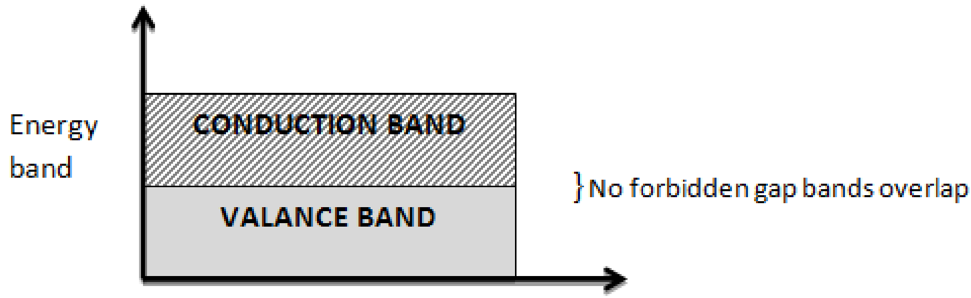
3) Limiting breaking current

4) Overload current

c) Sketch energy band diagram of conducting and insulating material and label it well. — **4 Marks**

Ans:

(i) Energy band diagram of conducting material



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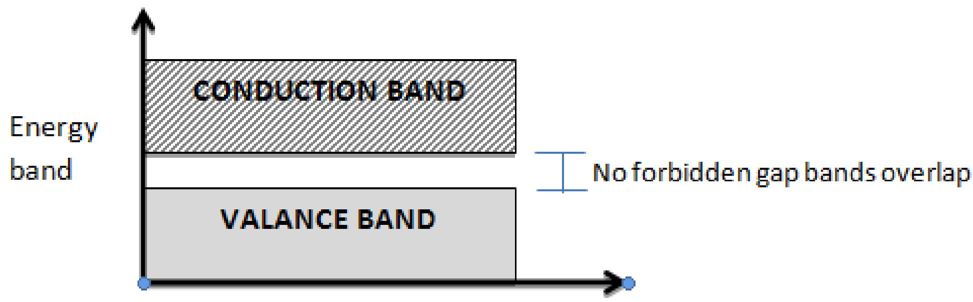
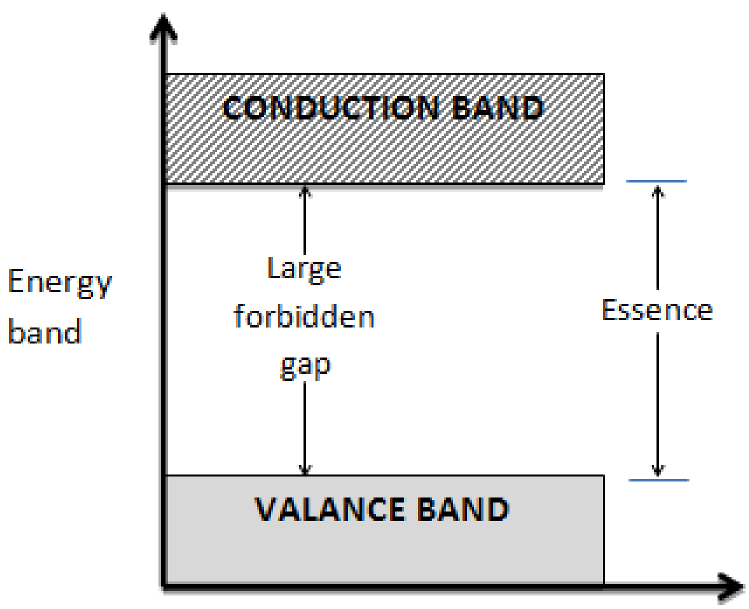
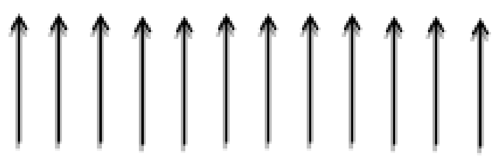
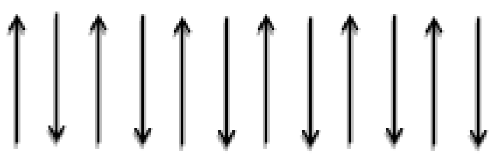
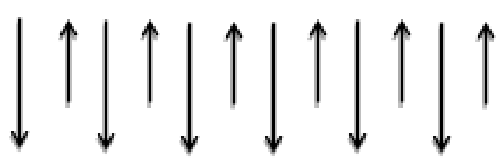
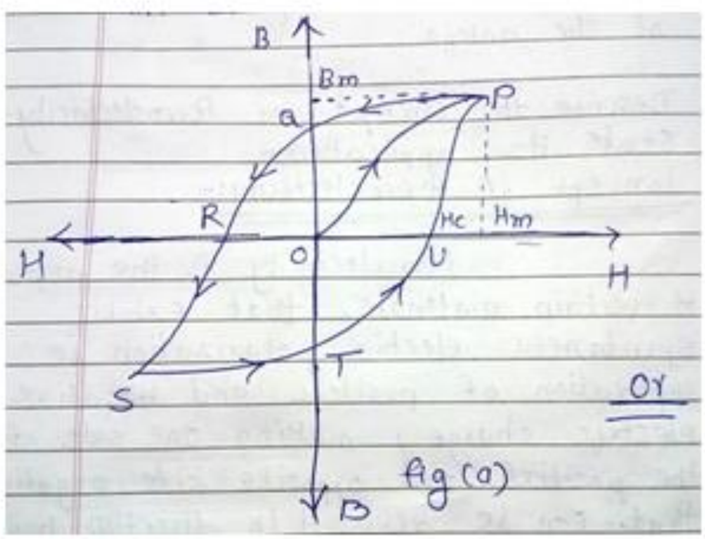


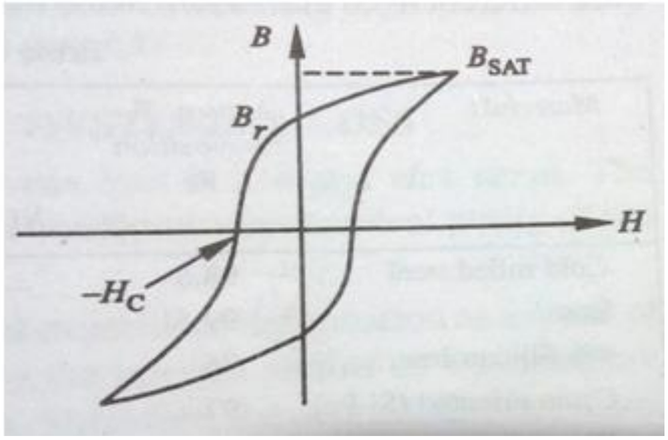
(ii) Energy band diagram of insulating material



2 Marks for each diagram

	d)	**Sketch orientation of spins in paramagnetic, ferromagnetic, anti-ferromagnetic and ferrimagnetic material.**	**4 Marks**
	Ans:	**(i) Paramagnetic**  Spins are randomly oriented **(ii) Ferromagnetic**  Spins are aligned parallel in magnetic domains **(iii) Anti- Ferromagnetic**  Spins are aligned antiparallel in magnetic domains **(iv)Ferrimagnetic**  Spins are aligned antiparallel but do not cancel	**1 Marks for each diagram**
Q. 4		**Attempt any THREE :**	**12 Marks**
	a)	**State any two characteristics of** **(i) Electro-textile** **(ii) Textile-antenna** **used for wearable antenna.**	**4 Marks**
	Ans:	**Characteristics of :-** i. **Electro-textile** 1) They have excellent radio frequency performance	**Any two characteristics-**

		2) They get more and more attention for body centric communication 3) They adopt woven pattern ii. **Textile-antenna** 1) The bandwidth of these antennas is between 2.52 GHz to 13.35 GHz 2) Textile materials get easily integrated into clothes and other wearable devices 3) It has very low dielectric constant that reduces the surface wave losses. 4) Increases the impedance bandwidth for the antenna.	**1 Mark each** **Any two characteristics- 1 Mark each**
	b)	**Describe the concept of ferroelectricity. State its applications.**	**4 Marks**
	Ans:	<u>**Concept of Ferro electricity**</u>**:-** Ferro electricity is the property of certain materials, that exhibit spontaneous electric polarization i.e. separation of positive and negative electric charge. Making one side of the positive and opposite side negative that can be reversed in direction by the application of an electric field. It contains small region which are polarized in different electronics filed. The Ferro electricity bears a close analogy to ferromagnetism. <u>**Application:**</u>**-** It is used in condensers to concentrate considerable quantities of electric energy within a small space.	**2 Marks for concept** **2 Marks for application**
	c)	**Describe with sketch B-H curve. State effect of change in temperature on area of B—H curve.**	**4 Marks**
	Ans:	 **OR**	**2 Marks for diagram**

		 Fig (b) The B-H curve can be plotted by increasing and decreasing the filed intensity. It is shown in fig (b) Below the Curie temperature all ferromagnetic materials exhibit the well known hysteresis in the *B* versus *H* curve. Starting with an unmagnified specimen, *B* varies reversibly with *H* for small fields. Since these is no hysteresis in this region, one defines the initial permeability, μ_r, in the same way as the permeability of a paramagnetic material. As the filed *H* is increased, *B* begins to increase rapidly and ultimately approaches a saturation value B_{sat}. Upon reducing the value of *H* from the saturation region to zero, it is observe that there remains a flux density B_r, called the remnant flux density. Since $H = O$, the material must be permanent magnetized; in fact, the magnetisation corresponding to B_r is equal to B_r/μ_o. The filed $-H_c$ required to reduce the flux density to zero is called the coercive force. **Effect of change in temperature on area of *B-H* curve** It is shown that at curie temperature saturation magnetization become zero and above that it becomes paramagnetic materials exhibit the well known phenomenon of hysteresis in the magnetization.	**1 Marks for description** **1 Marks for effect**
	d)	**State effect of temperature on superconductivity of metals.**	**4 Marks**
	Ans:	In the superconducting state, a materials possess zero electricity resistance and behaves as a perfectly diamagnetic material, above critical temperature T_C, superconducting property of the material is destroyed and material reverts back to it's normal state.	**4 Marks**
	e)	**State any two properties and application of following material :** **(i) Mica** **(ii) Transformer oil** **(iii) Rubber** **(iv) Polymer**	**4 Marks**
	Ans:		

		(i) Mica **Properties** 1. It is excellent insulation properties 2. It release water when heated 3. It has inorganic mineral material **Applications** 1. It is used in radio circuits, capacitor, radio tubes, segment insulation etc. 2. It is used in high voltage machines, traction motors, switches, plugs, fuse, holder, parts of sockets etc. **(ii) Transformer oil** **Properties** 1. It has higher resistivity 2. It has small viscosity 3. It has low density **Applications** 1. It is used for impregnation 2. It is used high voltage transformers, capacitors. **(iii) Rubber** **Properties** 1. It is an elastic substance 2. The vulcanized rubber is stretchable and elastic 3. **Application** 1. It is used in flexible wires, jack cards and installation wires 2. It is used in manufacturing tubes, tyres etc. **(iv) Polymer** **Properties** 1. It can be molded 2. It has ability to soften and even melt **Application** 1. It is used to produce yarns, cloths and films 2. The synthetic resins are popular in the electrical installations.	**1 Marks for any two properties** **1 Marks for any two apllications**
Q.5		**Attempt any TWO :**	**12 Marks**
	a)	**The resistivity of pure copper is 1.56 μ.Ω-cm. An alloy of copper containing 1 atomic percent nickel has a resistivity of 2.81 μ.Ω-cm. An alloy of copper containing 3 atomic percent silver has a resistivity of 1.98 μ.Ω-cm . Calculate the resistivity of copper alloy containing 2 atomic percent nickel and 2 atomic percent silver.**	**6 Marks**

	Ans:	Solution:- Resistivity of pure copper (ρ_{cu}) $\rho_{cu} = 1.56\ \mu\Omega cm$ ..... (given) Resistivity of alloy of copper and 1 atomic percent Nickel $= 2.81\ \mu\Omega cm$ ..... (given) ie $\rho_{(Cu+Ni)} = 2.81\ \mu\Omega cm$ $\therefore \rho_{Ni} = \rho_{(Cu+Ni)} - \rho_{cu}$ (2M) $\therefore \rho_{Ni} = 2.81 - 1.56$ $\rho_{Ni} = 1.25\ \mu\Omega cm$ Alloy of copper containing 3 atomic percent silver has resistivity of $1.98\ \mu\Omega cm$ ie $\rho_{Cu} + 3 \times \rho_{Ag} = 1.98$ $1.56 + 3 \times \rho_{Ag} = 1.98$ (2M) $\rho_{Ag} = \frac{1.98 - 1.56}{3}$ $\rho_{Ag} = 0.14\ \mu\Omega cm$ To calculate resistivity of copper alloy containing 2 atomic percent Nickel and 2 atomic percent Silver $\rho_{(Cu+Ni+Ag)} = \rho_{cu} + 2 \times \rho_{Ni} + 2 \times \rho_{Ag}$ (2M) $= 1.56 + 2 \times 1.25 + 2 \times 0.14$ $1.56 + 2.5 + 0.28$ $\rho_{(Cu+Ni+Ag)} = 4.34\ \mu\Omega cm$	**2 Marks** **2 Marks** **2 Marks**
	b)	**Classify-following material as diamagnetic, paramagnetic, ferromagnetic and anti-ferromagnetic :** **(i) Platinum** **(ii) Iron** **(iii) Glass** **(iv) Nickel oxide** **(V) Quartz**	**6 Marks**

		(vi) Silicon Iron alloy	
	Ans:	<table><tr><th>Materials</th><th>Classification</th></tr><tr><td>(i) Platinum</td><td>Paramagnetic</td></tr><tr><td>(ii) Iron</td><td>Ferromagnetic</td></tr><tr><td>(iii) Glass</td><td>Diamagnetic</td></tr><tr><td>(iv) Nickel oxide</td><td>Anti -ferromagnetic</td></tr><tr><td>(V) Quartz</td><td>Diamagnetic</td></tr><tr><td>(vi) Silicon Iron alloy</td><td>Ferromagnetic</td></tr></table>	**1 Marks each**
	c)	**Describe effect of plate area, thickness of dielectric material, permittivity on capacitance of a capacitor.**	**6 Marks**
	Ans:	The capacitance of capacitor in vacuum is given as $$Co = \frac{Qo}{V}$$ The capacitance of a capacitor in solid dielectric is given as $$C = \frac{Q}{V}$$ The capacitance of a parallel plate capacitor is given as $$C = \frac{\varepsilon A}{d}$$ Where 1. "A" is the cross sectional area of metal plates and it is directly proportional to capacitance. As "A" increases Capacitance is also increases. 2. "d" is the thickness of dielectric material and it is inversely proportional to capacitance. As "d" increases Capacitance is also decreases and vice-versa. 3. "ε"is the relative permittivity of free space and it is directly proportional to capacitance. As "ε" increases "C " also increases.	**1 Marks** **2 Marks** **1 Marks** **1 Marks** **1 Marks**
Q.6	**A)**	**Attempt any TWO :**	**12 Marks**
	a)	**Explain thermal conductivity and coefficient of thermal conductivity in semiconductor material.**	**6 Marks**
	Ans:	**Thermal conductivity:-** Thermal conductivity (often denoted k, λ, or κ) is the property of a material to conduct heat. It is evaluated primarily in terms of the Fourier's Law for heat conduction. In general, thermal conductivity is a tensor property, expressing the anisotropy of the property. Heat transfer occurs at a lower rate in materials of low thermal conductivity than in materials of high thermal conductivity. Correspondingly, materials of high thermal conductivity are widely used in heat sink applications and materials of low thermal conductivity are used as thermal insulation. The thermal conductivity of a material may depend on temperature. **Examples of Coefficient of thermal conductivity in semiconductor material:-**	**3 Marks**

Semiconductors	Thermal Conductivity (k)
AlGaAs	90
GaAs	46 to 55
GaN	40 to 130
Ge	58 to 60
InP	68
Si	140 to 163
SiC	16 to 55

3 Marks

b) **Explain hysteresis loss and eddy current loss of magnetic material.** **6 Marks**

Ans: **3 Marks**

Hysteresis loss of magnetic material:-

- It is also known as Iron Loss or Core Loss and it is always constant.
- Hysteresis loss is due to the reversal of magnetization of transformer core whenever it is subjected to alternating nature of magnetizing force .Whenever the core is subjected to an alternating magnetic field, the domain present in the material will change their orientation after every half cycle. The power consumed by the magnetic domains for changing the orientation after every half cycle is called Hysteresis loss.
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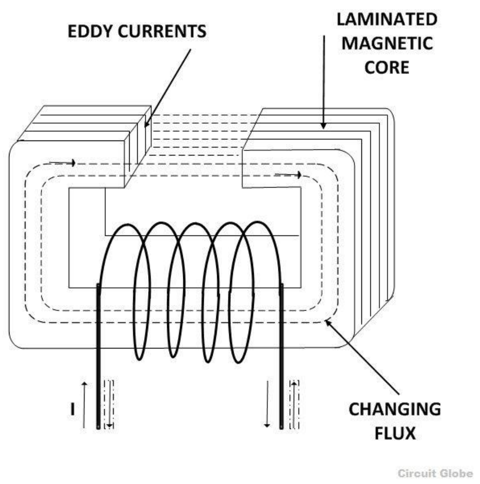
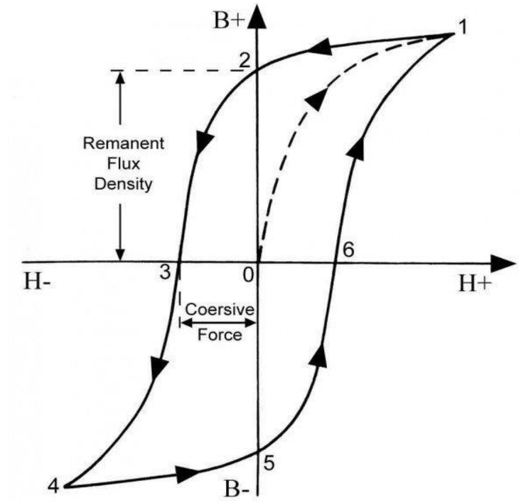
Eddy current loss of magnetic material:- **3 Marks**

- When an alternating magnetic field is applied to a magnetic material an emf is induced in the material itself according to Faraday's Law of Electromagnetic induction. Since the magnetic material is a conducting material, these EMFs circulates currents within the body of the material. These circulating currents are called Eddy Currents. Eddy current will occur when the conductor experiences a changing magnetic field. It produces a loss (I^2R loss) in the magnetic material known as an Eddy Current Loss.
- Similar to hysteresis loss, eddy current loss also increases the temperature of the magnetic material. The hysteresis and the eddy current losses in a magnetic material are also known by the name iron losses or core losses or magnetic losses.

		 	**Diagram is optional.**
	c)	**Suggest two passive materials used for substrate. metal and capacitance of semiconductor device fabrication. State their two functions.**	**6 Marks**
	Ans:	**Passive materials** **(i)Substrate:** most widely used substrate are either plastic, glass or ceramic. **Functions:** i) They are used for deposition of thin films layers. (iii) Plastic substrate is used only for thin film solar cells. (iv) Glass or ceramic are used for deposition of metals for resistors and capacitors **(ii)Metals:** Commonly used metals are gold,platinium,Aluminiun,Nickel-chromium . **Functions :** (i) They act as capacitor plates (ii) They are used for resistors (iii) For mechanical support. (iv) As heat dissipater. **(iii) Capacitance materials :**commonly used capacitance material are SiO,ZnS,SiO_2,TiO2,BaTiO2,MgF2,Ta2O5,Al2O3 **Functions :** (i) a pin-hole free continuous layer (ii) High dielectric constant (iii) A low loss factor at the desired frequency (iv) Ability to withstand thermal stresses without cracking	**1 Marks (Any 2)** **1 Marks (Any 2)** **1 Marks (Any 2)** **1 Marks (Any 2)** **1 Marks (Any 2)** **1 Marks (Any 2)**